such solution was recommended by alchemists as a necessary constituent of the elixir vitæ, and essential for the work of transmutation. In Fig. 11 the solution of gold in the flask is represented by the sun emitting rays. The simple disc of the sun is the more common symbol for gold.

Arnoldus also distilled various oils and essences. He contended that sulphur, arsenic, mercury, and sal ammoniac—all volatile bodies be it noted—are the souls of metals, and are given off during calcination. He also affirmed that silver is intermediate between mercury and other metals, just as the soul is intermediate between the spirit and the body. Arnoldus is said to have had for his pupil Pope John XXII., an accomplished alchemist, who left at his death eighteen millions of florins, which the alchemists fondly cite as a proof of the possibility of transmutation. Our own George Ripley, Canon of Bridlington in Yorkshire (b. about 1460) wrote a poem on alchemy, and passed for a successful disciple of the art, but we cannot point to a new fact which he elucidated. He divided all chemical operations into twelve processes—Calcination, dissolution, separation, conjunction, putrefaction, congelation, cibation, sublimation, fermentation, exaltation, multiplication, and projection. Several MS. copies of his poem exist in the British Museum, bound up with copies of the works of Roger Bacon and earlier writers. Here is a specimen of his rugged rhymes:—

The fyrst chapter shall be of naturall *Calcination* ;
The second of *Dyssolution*, secret and phylosophycall ;
The third of our elementall *Separation* ;
The fourth of *Conjunction* matrimoniall ;
The fyfth of *Putrefaction* then followe shall :
Of *Congelation Albyficative* shall be the sixt,
Then of *Cybation*, the seaventh shall follow next.

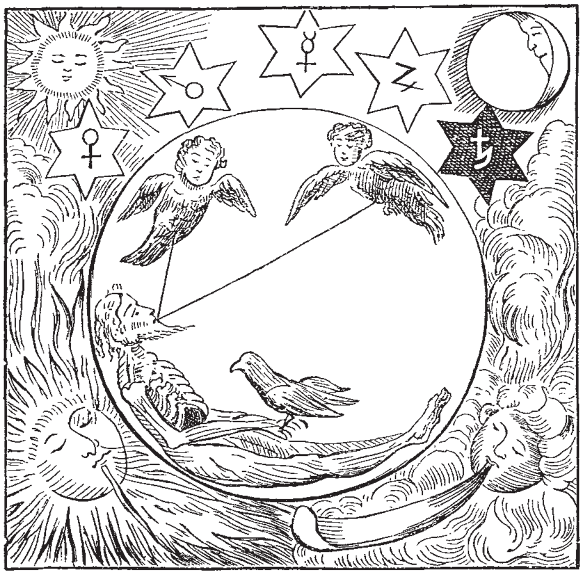

FIG. 13.—Alchemical representation of processes.

One of the most celebrated of the alchemists was Basil Valentine, who was born at Erfurt in 1394. According to Olaus Borrichius his works were accidentally discovered in the wall of a church at Erfurt many years after his death. A thunderbolt struck the church and exposed to view the long-lost alchemistical treasures. Basil Valentine was the author of many treatises, the most important being his "Currus Triumphalis Antimonii," in which he discusses the properties of antimony and of many of its compounds. He regarded the metals as compounds of salt, sulphur, and mercury; and he was acquainted with many metallic compounds, among others nitrate of mercury, sulphide of arsenic, red oxide of mercury, chloride of iron, sulphate of iron, fulminating gold, carbonate of lead, acetate of lead, and the oxides of lead. He was aware that iron precipitates copper from solution, and that solution of potash precipitates iron from solution. He was well acquainted with the preparation of nitric and sulphuric acids, and used them for various purposes of dissolution. In order to obtain nitric acid he distilled powdered earthenware with nitre, or equal parts of nitre and green vitriol, or nitre with finely powdered flints. He obtained fuming sulphuric acid by distilling green vitriol, after the manner still practiced at Nordhousen and elsewhere. Basil Valentine wrote very obscurely and was fond of symbolical designs. Woodcuts 12 and 13 are taken from his works, and represent various processes imperfectly described. Thus the lion in Fig. 12 would represent a solution of a metal, the serpent another solution, or perhaps the serpent a metal, and the lion devouring it a solvent ; the sun and moon are watching the operation, and the symbol of mercury appears between two roses. Fig. 13 represents some operation which is thus thus described by the principal figure :—I am an old, infirm, debilitated man, my soul and spirit (represented by the two boy-headed birds above his head) leave me, and I assimulate the black crow. In my body are found salt, sulphur, and mercury. This may possibly refer to the solution of gold in aqua regia : it loses its metallic nature, its solidity and lustre, and assimulates the acid ; but one may conjecture in vain concerning the enigmatical devices in which some of the alchemists took so much delight, and which they often employed, like Roger Bacon's anagram, to conceal the full significance of their operations or discoveries.

The following extract, in which he treats of the generation of metals, will show the style of Basil Valentine's writing:—

"Therefore think most diligently about this; often bear in mind, observe, and comprehend that all minerals and metals together in the same time, and after the same fashion, and of one and the same principal matter are produced and generated. That matter is no other than a mere vapour, which is extracted from the elementary earth by the superior stars or by a sidereal distillation of the macrocosm, which sidereal hot infusion, with an airy sulphureous property, descending upon inferiors, so acts and operates, as in those metals and minerals is implanted spiritually and invisibly a certain power and virtue, which fume afterwards resolves in the earth into a certain water, from which mineral water all metals are thenceforth generated and ripened to their perfection, and thence proceeds this or that metal or mineral according as one of the three principles acquires dominion, and they have much or little of sulphur and salt, or an unequal mixture of them ; whence some metals are fixed, that is constant or stable ; some volatile and easily mutable, as is seen in gold, silver, copper, iron, lead, and tin."

Now this is by no means the most obscure piece of alchemical writings with which we shall come in contact.

G. F. RODWELL

GLACIER MOTION

IN making some experiments on the freezing of water some time ago it was noticed that after the same water had been melted and frozen a number of times it generally burst the tube in which it was frozen. On looking for an explanation of this phenomenon, it became at once evident that the experiment contained the germ of the explanation of glacier motion. Every time the water was frozen in the tube there was a mimic representation of glacier motion. The ice possessed, the first two or three times it was frozen, a certain amount of viscosity which enabled it to adapt itself to the shape of the tube, as was evident from the distortion of the upper surface of the ice in the tube. How came the ice to lose this plasticity or viscosity, this power of adapting itself to the shape of the tube, the loss of which caused it to burst the tube after it had been frozen and melted a number of times? Wherein did the ice which had only been frozen once differ from the other? The answer to this seemed to be, that the ice which had only been frozen once had more air in it than that which had been frozen and melted a number of times, as each succeeding freezing deprived the ice of a quantity of air or some other gases. The natural conclusion, therefore, seemed to be, that ice with air in it is a viscous substance, though pure ice is not. The first question then to be asked is, Is ice with air in it a viscous substance? In order to get an answer to this question, glass tubes ·4-inch in diameter and twelve inches long were filled with water in which was dissolved a great quantity of air. The tubes were then placed in a freezing mixture. After the water was frozen in the tubes the tubes were

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slightly heated and the rods of ice withdrawn from them and placed on two supports eight and a half inches apart, and a weight of one pound hung from the centre of these ice beams. The beams at once began bending and continued bending so long as the weights were left on them, thus proving the viscosity of the ice experimented on. The ice of these beams though similar was not the same as glacier ice; other ice beams were therefore made, in as close imitation of glacier ice as possible, which was done by placing a small quantity of water in the tubes, then some snow, and pressing it firmly to the bottom of the tubes, then adding more snow, and again firmly pressing it down, and so on till the tubes were filled, as much pressure being applied as possible to the snow to drive out the water. The tubes were then placed for some time in the freezing mixture. The ice beams were afterwards withdrawn from the tubes and placed on the supports, and a weight of one pound hung from the centre. The beams of snow ice so made were found to be more easily bent than those made from the water. The rate at which they bent varied, possibly owing to there being more or less water-ice mixed with the snow-ice: one of the beams bent one inch in five minutes. Temperature seemed to have some influence on the rate of bending of these beams, but this point was difficult to determine on account of the different beams bending at different rates at the same temperature; but so far as could be ascertained from the experiments, the beams bent slower the lower the temperature. The lowest temperature used in these experiments was rather more than three Fahrenheit degrees below freezing.

Smaller rods of snow-ice were then made ·2-inch in diameter, and as it was found that these could be easily bent in the hand, it was thought possible to bend them into rings. In attempting to bend these rods round a cylinder three inches in diameter, a difficulty was met with. After the pressure had been applied a short time, and before the circle was half turned, the rods always broke with a pressure which they easily bore at the beginning. Here, then, was a difficulty. The explanation seemed to fail at the last moment. The bending had so altered the structure of the ice, that it had lost much of its viscosity and become brittle. How then are we to account for glacier ice keeping its viscosity after years of bending. On examining the fracture of the beams it appeared as if a fibrous structure had been developed in the ice by the bending. The fracture did not go straight across, but part of it ran parallel with the axis of the beam, strongly resembling the fracture of poor bar iron, crystalline at one part, fibrous at another. The bending of the ice had evidently developed a laminated structure in it, similar to that found in glaciers. This laminated structure was developed along the beams, as was to be expected; for the direction in which this structure will be developed depends more on the direction in which the particles of ice are caused to slip over each other, than on the direction in which the pressure or tension is applied. The bending having produced this laminated structure in the ice, it is evident that the beams will be weaker after this structure is developed than before, on account of the cohesion of the ice being weakened along the planes of lamination. It was thought therefore that if the pressure was taken off the ice so as to relieve the particles from strain and stop them sliding over each other, that the laminæ which had been developed in the ice, would, so to speak, become welded together, and the strength and plasticity of the beam be restored. Acting on this supposition an attempt was again made to bend the ice-beam into a circle. After a small part of the circle had been turned, the pressure was taken off the beam and a short time given for the particles to rearrange themselves; the pressure was then again applied, a small part more bent and so on. When done in this way it was found that the ice-beams were easily bent into a circle, the ends were then united by means of pressure, and a solid ring was thus produced from a straight beam of ice. These conditions of alternate rest and pressure are in all probability those which exist in glaciers. After pressure has acted at one part of the glacier, bending takes place, so relieving the ice at that part from the pressure, which comes to bear on another part of the glacier; and before the pressure again comes to bear on the first part its strength and plasticity or viscosity has been restored by rest.

Although ice under certain conditions has by these experiments been shown to be a viscous substance, to have the power of changing its shape and so enabling it to flow—though slowly—in its channel; although it has thus been shown that the viscosity of ice is a cause of glacier motion, yet it must not, therefore, be concluded that it is the only cause. Among other causes which may assist in producing glacier motion may be mentioned: 1st. The sliding of the ice over its channel; this sliding being assisted by the tendency which the ice has to melt where it rests on its channel. 2nd. The melting of the ice in front of obstacles, the melting being produced by the melting point of the ice in contact with the obstacle being lowered by the pressure of the ice behind. 3rd. The melting of the ice in the body of the glacier, by heavy pressure being brought to bear at certain points, part of the water so formed finding its way to the channel under the ice, and part being re-frozen. 4th. The crevasses in the glacier formed by the fracture of the ice. This breaking up of the ice will enable large masses of ice to move into different positions relatively to each other, much more easily than if the ice was solid. This breaking up of the ice will also make the motion due to its viscosity take place quicker than if the ice was in one mass. 5th. The old dilatation theory explains something of the motion of glaciers, though it may not explain how that motion takes place, yet it accounts for some of the pressure which produces that motion.

JOHN AITKEN

SUB-WEALDEN EXPLORATION

SINCE the last quarterly report, troublesome accidents have delayed this undertaking. On the very day of the meeting in Jermyn Street in December last, the drilling tool broke off close to the edge, leaving a flat chisel (9 in. wide tapering up to 2 in.) at the bottom of the bore. A fortnight was lost in the endeavour to extract it. Mr. Bosworth's ingenuity and patience were sorely tried; but he at last succeeded in bringing it to the top from a depth of about 96 ft. 34 ft. consisting of narrow bands of calcareous shale, alternating with argillaceous limestone in layers of from 4 to 6 in. were passed through; but on January 28, at 131 ft. from the surface, a bed of pure solid white gypsum 4 ft. in thickness, was reached and perforated, the new trifid drilling tool bringing up solid cores. This is the first time a bed of gypsum of this character has been found in Sussex, and it probably indicates the presence of the Purbeck beds. If so, strata hitherto unknown to exist in Sussex are now added to our geological information, and the scientific world will have its interest re-awakened to this, the first boring attempted in England for purely scientific purposes. Boring is a tedious and expensive process, and we hear that the preliminary cost of machinery has exhausted the treasury. Subscriptions are earnestly requested to complete the second sum of 1000*l.* promised on condition that 2000*l.* be raised. Mr. Henry Willett, Arnold House, Brighton, will be pleased to receive any sums for the purpose. It would be a great disaster indeed if the boring had to be stopped for want of funds; but we feel sure that when the state of matters is made known to the friends of science Mr. Willett will soon have to report a full treasury.

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